[imparting crystallinity to] crystallizing the amorphous silicon film using the metal element by irradiating it with laser light; and

heating the crystallized silicon film.

REMARKS

The Office Action of January 23, 1996 was received and carefully reviewed. In response thereto, the Title is replaced, claims 1-4, 6, 10, 11, 14, 17, 18, 21 and 22 are amended and claims 5 and 16 are cancelled. Reconsideration and withdrawal of the currently pending rejections are respectfully requested. Claims 1-4, 6-15 and 17-22 are currently pending in the instant application.

With respect to the formal rejections, the Title is replaced herein to be more descriptive of the presently claimed invention.

Claims 1-22 are rejected under 35 U.S.C. §112, second paragraph, for being indefinite. The rejection of claims 5 and 16 is rendered moot by the cancellation of these claims.

With respect to claim 11 and 17, these claims are amended to more clearly recite the present invention which should be sufficient to overcome the §112 rejection thereof. Further, claim 18 is amended to overcome this rejection by deleting the word "water".

With respect to the rejection over the references, claims 1, 2, 5 and 21 are rejected under 35 U.S.C. §102(b) over Liu et al., and claims 1, 2, 5-7, 10-12 and 21-22 are rejected under 35 U.S.C. §103 as being unpatentable over Fonash et al., in view of Liu et al. These rejections are respectfully traversed for the reasons advanced in detail below.

Claims 1, 2, 6, 11, 21 and 22 all recite a method of manufacturing a semiconductor film wherein a silicon film is crystallized by laser

irradiation using a catalytic element, such as nickel, and then heating the crystallized semiconductor film to decrease the number of defects, particularly, to decrease spin density and dangling bonds, respectively, in the crystallized semiconductor film.

As provided on page 11 of the specification, a heat treatment performed after irradiation with laser light reduces defects in the crystalline silicon film. Figure 8 specifically shows the results of measurements in which spin densities of resulting crystalline films were measured which were found to correspond to dangling bonds in the film. Sample No. 4 of Figure 8 has the lowest spin density, and, thus, the lowest number of dangling bonds. By comparing Sample No. 3 with Sample No. 4, it can be seen that the number of defects in the silicon film after laser crystallization can be reduced by an order of one when the film is subjected to a subsequent heat treatment. Figure 8 also shows that the laser irradiation causes almost no change in the number of defects in the silicon film. (See, Sample Nos. 2 and 3).

The Examiner indicates that Fonash discloses that the samples are held at 400°C during the deposition of a silicon dioxide film and contends that this corresponds to a subsequent heat treatment. This disclosure is not sufficient to suggest a heat treating step wherein the heat treating step is sufficient to reduce defects in the film. In fact, the disclosure of instant application clearly indicates that if the temperature is too low, that is below 450°C, the heat treating step will not be sufficient to eliminate defects unless performed for an extended period of time. Fonash et al. fails to disclose the length of time the silicon dioxide deposition occurs, and, thus, does not include sufficient teaching to suggest the subsequent heat treating step of the present invention.

Moreover, because the temperature disclosed by Fonash et al. is 400°C, it is improper to contend that the method disclosed by Fonash et al. would inherently produce the reduction in spin density and/or dangling bonds without more disclosure of timing. Consequently, Fonash et al. fails to disclose or suggest the subsequent heating step as defined in the present invention. Since Liu et al. and Fonash et al. fail to disclose a heat treating step subsequent to laser irradiation to reduce spin density or the number of dangling bonds in the crystallized layer, claims 1, 2, 6, 11, 21, 22 and the claims depending therefrom should be considered allowable.

Further, the catalytic element of the present invention can be applied to the silicon film by solution application, as expressly recited in claims 6, 11, 21 and 22. The specification clearly indicates that application of the catalyst element by solution is highly effective in applying a controllable and minimal amount of catalyst to the silicon film, since too much catalyst can reduce the effectiveness of the resulting crystallized layer. (See, pages 7 and 8 of the specification.) Since Liu et al. and Fonash et al. fail to disclose such solution application of a catalyst element, these claims and the claims depending therefrom are further distinguishable over these references.

Claims 3-4, 8-9 and 13 are rejected under 35 U.S.C. §103 over Liu et al. and Fonash et al., further in view of Hemple et al. or Hayzelden et al. These claims depend from claims 1 and 6. Consequently, for the reasons advanced above with respect to claims 1 and 6, these claims should likewise be considered allowable.

Claims 1-3, 6-8 and 11-13 are rejected under 35 U.S.C. §102(b) as anticipated by Celler. This rejection is also respectfully traversed.

Specifically, claims 1 and 2 are amended to expressly recite that the thermal annealing subsequent to laser irradiation is provided to decrease spin density and the number of dangling bonds, respectively, in the crystallized film. This is not disclosed by Celler. Consequently, since all of the elements of claims 1-3 are not disclosed in Celler, it is respectfully requested that this rejection be reconsidered and withdrawn.

Further, claim 6 is amended to recite the solution application of the metal element for promoting crystallization, which is also not disclosed in Celler. As a result, it is respectfully requested that the rejection of claim 6 and claims 7, 8, 11-13 depending therefrom also be reconsidered and withdrawn.

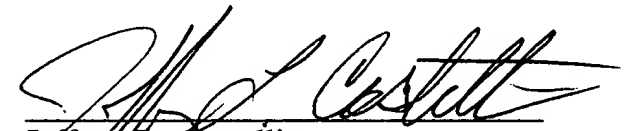
Claims 14-20 are rejected under 35 U.S.C. §103 over Liu et al., Fonash et al. or Celler, in view of Pressley. Pressley merely discloses the use of a solution for "dopants". There is absolutely no disclosure that the use of solution application would be adequate for contacting a crystallization catalyst material with silicon. The Examiner has failed to cite a reference indicating the catalyst metals capable of promoting crystallization are considered merely as "dopants". In fact, the teachings of Liu et al. and Fonash et al. would appear to teach to the contrary of Pressley, and, thus, the Examiner's conclusion, since these references teach that catalyst metals can be formed as a layer in contact with the silicon.

Further, Liu et al. and Fonash et al. teach that the catalyst metal should be discontinuous in the form of globules. (See, claims of Fonash et al. and col. 3, lines 60+ of Liu et al.) As a result, one of skill in the art would be taught from these references that solution application would not be appropriate since such application would not produce a discontinuous
forming globules on the Si,

film forming globules on the silicon film. Consequently, it is respectfully requested that this rejection be reconsidered and withdrawn.

In view of the foregoing, it is respectfully requested that the rejections of record be reconsidered and withdrawn by the Examiner, that claims 1-4, 6-15 and 17-22 be allowed and that the application be passed to issue. If the Examiner believes a conference would be of benefit in expediting the prosecution of the instant application, he is hereby invited to telephone counsel to arrange such a conference.

Respectfully submitted,



Jeffrey L. Costellia
Reg. No. 35,483

Sixbey, Friedman, Leedom & Ferguson, P.C.
2010 Corporate Ridge, Suite 600
McLean, Virginia 22102
(703) 790-9110